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Taxonomic Study of Bees: Hymenoptera from the Painganga Wild life Sanctuary with reference to Superfamily Apoidea

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1. A Brief resume of proposed work problem

Proposed research will include a study of Bees: Hymenoptera from the Painganga Wildlife Sanctuary with reference to superfamily Apoidea. Bees are the most important pollinators because particular bee species often specialized on particular plant species. Many Researchers through out globe and within India have been work on the taxonomic study of the subfamily Apoidea, but the Proposed region Painganga Wild life Sanctuary, and State Maharashtra lack such kind of taxonomic studies. So proposed research work will essentially contribute in generating ecological information superfamily Apoidea, about the date of collection and the plant hosts for each species, there taxonomic keys to isolate the species, genera and families, as well as document the bee fauna of Painganga Wild life Sanctuary that may provide baseline data for future research on bee biodiversity, ecology, and conservation. Such kindly of taxonomic study on the Super family Apoidea will also helpful agricultural field in regards with pollination of many crops to improve the yield and sustain the economic of the farmer of the region. Bee species-level research that is extremely dynamic, urgently needed, and in line with contemporary social values and requirements is essential. The taxonomic barrier that currently prevents pollinator status and pollination services from being evaluated will be directly addressed by efforts centered on proposed research work.

Taxonomic Study of Bees: Hymenoptera from the Painganga Wild life Sanctuary with reference to superfamily Apoidea

2. INTRODUCTION

Bees (Anthophila) are members of the superfamily Apoidea which are playing important role in pollination of angiosperms and the greatest number of commercial crops are pollinated by the help of them (Ascher and Pickering, 2021, Grab, 2019, Michener, 2007, Engel, 2001, Dias et al., 1999). Michener (2007) further classified the superfamily Apoidea into seven families namely, *Andrenidae, Apidae, Colletidae, Halictidae, Megachilidae, Melittidae,* and *Stenotritidae*. *Megachilidae, Anthophoridae* and *Bombus* Latreille species are being used in agriculture for their hopes in pollination since the early 20th century (Free, 1993). Ascher and Pickering (2021), reported that the total number of bee species in the world could have been 20507. Moreover, by careful inspections this number would become high as 25000. According to current data, Halictidae includes 3,500 species (Pesenko, 2007), while Bombini approximately 300 species (Aytekin et al., 2007) in the world Megachilidae includes 3.150 species, Andrena 1112 species and Xylocopa 469 species in the world (Michener, 2000). A total number of 1219 Megachilidae species are distributed in the Palaearctic region (Banaszak and Romasenko, 1998).

The superfamily Apoidea, is well known mostly for their relationships with flowering plants (according to current usage Apoidea is a monophyletic group composed of both the sphecid wasps and the true bees called Apiformes or Anthophila (Kumari and Sidhu, 2020) (Michener, 2007). Unlike other hymenopterans, bees specialized exclusively on vegetarian diets. Both immature bees and adults eat plant-derived pollen for protein and nectar for energy (Delapane and Mayer, 2000). Probably, the most important activity of bees, in terms of human benefit, is their pollination of natural flowering vegetation, something that is rarely observed or appreciated by non-specialists (Michener, 2007).

These pollinators perform a crucial ecosystem function that allows many plants to reproduce sexually and by out-crossing. They help people by boosting livelihoods, ensuring more access to food, and preserving biological variety in agricultural and natural settings (Eardley et al., 2006). Preservation of this vegetation may be necessary to stop erosion and

other issues, as well as to give wildlife food and cover (Pimentel, 2006; Michener, 2007 and Zurbuchen et al., 2010). Therefore, maintaining bee populations is essential for the sustainability of many environments, as their extinction could drastically restrict the reproduction of key flora components (Michener, 2007).

Bees are the most important pollinators because particular bee species often specializedon particular plant species (Eardley et al., 2010). Even among the more generalist bee species, there are often strong feeding preferences. Understanding the importance of wild bees as pollinators depends on knowledge of the diversity of bees (Michener, 2007). Among the different groups of bees there are a variety of different behaviors. Most species are solitary, although many are semi-social and some are eusocial. Whereas most collect pollen, some are social parasites (they replace the queen and use the host workers to raise their progeny), clepto parasites (cuckoo bees, who lay their eggs on the host species larval provisions) or robbers (who steal pollen and honey from the other bee's nests) (Eardley et al., 2010).

Purpose of Propose Research work

Due to the lack of taxonomic studies of this superfamily in Painganga Wild life Sanctuary, so the aims of present works are:

- A comprehensive survey of some localities of Painganga Wild life Sanctuary to collect the samples of the bees.
- A detailed description of the type of the superfamily and the available species.
- To Formulate of taxonomic keys to isolate the species, genera and families.
- Identification of species according to the diagnostic characters.
- Drawing of the important parts of each species.
- Recording some ecological information such as localities, date of collection and the plant hosts for each species.
- Thus, this study aims to document the bee fauna of Painganga Wild life Sanctuary that may provide baseline data for future research on bee biodiversity, ecology, and conservation.

3. REVIEW OF LITERATURE AND DEVELOPMENT IN THE SUBJECT

3.1 Taxonomic studies of the Superfamily Apoidea Latreille, 1802

Globally bee fauna contain approximately 20507 species, in seven families (Ascher and Pickering, 2021 and Michener, 2007). They are usually divided into two variously named groups (Michener, 2007), one consisting of short-tongued bees and the other of long-tongued bees (Gonzalez-Vaquero and Roig-Alsina, 2013). Kirby (1802) placed all bees in two genera, Melitta for the S-T bees and Apis for the L-T bees. In the same year, Latreille (1802) recognized the same two groups as families, with certain super generic and subdivisions. Klug (1807) gave a summary listing 32 bee genera. Lepeletier (1841) separated the social Apinae (Bombus, Melipona and Apis) in a separate account (1835). Other bees divided into two major groups, the solitary nesters and the parasites (1841). Schenck (1861, 1869) in accounts of the bees of Nassau, Germany, provided the classification using the 1869 version with interpretation as necessary from that of 1861. Thomson (1872) made a classification that in various ways is more modern than those of earlier writers, although he called the main named divisions tribes. Schmiedeknecht (1882); Friese (1895) and subsequent works as late as (Schmiedeknecht, 1930) reverted to a system similar to that of Lepeletier they recognized three sections, the solitary nest-making bees, the social bees, and the parasitic bees. Ashmead (1899) greatly modified (Schmiedeknechts, 1882) system and included genera from all parts of the world. (Robertson, 1904) thoughtfully developed a new classification for bees; his families were widely accepted by North American hymenopterists such as (Viereck, 1916) and by American textbook writers. Bomer (1919) constructed a classification that, for ST bees, fore shadowed some later classifications. The parasitic bees were appropriately placed, as shown by (Grutte, 1935), who followed Borners system. Some taxa, such as Macropis, Melitta, and the Ceratinini, were misplaced, and the Nomiinae and Halictinae were mixed, as being the Osmiini and Megachilini. Grutte (1935) made use of Bischoffs findings in a study of parasitic bees. Gonzalez and Griswold (2012) recorded three new species of cleptobiotic stingless bees of the genus *Lestrimelitta Friese, L.opita* sp. n. and *Lhuilensis* sp. from Colombia and *Lcatira* sp. n. from Venezuela, are described and figured. Sheffield and Genaro (2013) recorded a new species of Megachile (Litomegachile) droegei from Cuba.

3.2. Taxonomic studies of the Family Apidae Latreille, 1802

Apidae is the largest family of bees, with over 5,700 described species (Ascher and Pickering, 2021; 2013). Apid bees are widespread, but their greatest diversity is in the Neotropical and Oriental regions, where they compose a large proportion of bee species. Apidae includes the most important managed pollinator, the honey bee (*Apis mellifera*), is an enormously diverse group with varied life histories. Many species are ground nesting (eg, *Emphorini, Eucerini*), but some are nestting in wood (e.g. Xylocopini and Tetrapedia) or stems (e.g., Serotonin and Allodapini) or construct nests from plant resins (eg, Euglossini and Meliponini). Both primitive (e.g. Allodapini and Bombini) and advanced (e.g., Meliponini and Apini) eusociality occurs in Apidae (Buchmann, 1987). The number of species of honey bees recognized over the last two and a half centuries has varied quite considerably, following the original descriptions of four species of *Apis mellifera* Linnaeus (1758) and *Apis florea* Linnaeus (1787). *Apis cerana* Fabricius (1793) and *Apis dorsata* Fabricius (1793). Gerstacker (1863) published the first comprehensive phylogenetic and taxonomic treatise on Apis, and reduced all previously described forms (except *A. andreniformis* and *A. nigrocincta*, which he either missed or ignored) to only the original four Linnean and Fabrician species. Smith (1865) subsequently presented his case for seven species. Maa (1953) published an abstruse monograph in which he introduced some 24 species of honeybees within four genera. Ruttner (1992) published his natural history of honey bees; he included *Apis laboriosa*, *Apis andreniformis* and *Apis koschevnikovi* alongside the "traditional" four species. Engel (1999) applied a phylogenetic species concept and accordingly regarded *A. laboriosa* and *A. nuluensisas* synonyms of *A. dorsata* and *A. cerana*, respectively a view that has not been widely accepted by apiculturists, who have tended to employ alternate species concepts (that is either the biological species or the evolutionary species concepts). Brooks (1999) revised bees of the genus *Anthophora Latreille*, 1803 of the West Indies for the first time. Williams et al. (2008) suggested four criteria to guide the process of simplifying the subgeneric system, so that ideally subgenera should become monophyletic fewer diagnosable from morphology and names for important behavioral and ecological groups. Hinojosa-Diaz and Engel (2011) described *Euglossa williamsi* as a new species from the Amazon Basin of Ecuador and Peru. Gonzalez and Griswold (2012) described three new species of cleptobiotic stingless bees of the genus *Lestrimelitta Friese*, *L.opita* and *L. huilensis* from Colombia and *L. catira* from Venezuela. Nemesio et al. (2013) described *Eufriesea zhangi* as a new species from Brazil.

3.3 Taxonomic studies of the Superfamily Apoidea Latreille, 1802

Chandra (2019) reported Altogether, 119 species belonging to 32 genera, 11 subfamilies and 05 families have been reported from the state of Punjab so far. The maximum species diversity is recorded in the family Apidae (41 species) followed by Megachilidae (40 species), Halictidae (27 species) andrenidae (7 species) and Colletidae (4 species) in their studies on species diversity of superfamily Apoidea (Hymenoptera) from the state of Punjab, India.

Hooda and Jain (2020) reported a total of 44 species which has been cataloged from the aforesaid area belonging to 19 genera encompassing 8 subfamilies of 4 families, viz. Apidae, Megachilidae, Halictidae, and Andrenidae from the Kota region of Rajasthan.

Roy and Kundu (1985) reported 10 bee species from Namdapha National Park in which 4 species are not included in our collection viz., *Lipotriches fulvinerva* (Cameron, 1907), *Thyreus smithii* (Dalla Torre, 1896), *Anthophora zonata* (Linnaeus), and *Bombus orientalis* Smith.

Saini et al., 2018) Published preliminary checklist of bee diversity with record of 49 species belonging to 12 genera under 03 families viz. Apidae, Halictidae, and Megachilidae. Family Megachilidae, Genus Ceratina and 13 species of bees are recorded first time from Arunachal Pradesh, India

3.4 Biological studies of the Superfamily Apoidea Latreille, 1802

Many researchers (Weislo and Cane, 1996; Danforth, 1999; Cook,1993 and Michener, 2007) studied the life cycle of bees. With complete metamorphosis, bees pass through four discrete life stages. Bee eggs are sausage-shaped. Those of the solitary, non-parasitic species can be proportionally huge for an insect; eggs of some large carpenter bees (Xylocopa) are 16 mm long. Non-social bee species are much less fecund than most insects, laying only 10-25 eggs in their lifetimes, averaging one to two per day. As with other Hymenoptera progeny, sex is determined by egg fertilization: male eggs remain unfertilized and are thus haploid. Bee larvae are gently curved soft, white, blind, largely immobile and defenseless grubs. Only specialized instance of some cleptoparasitic species is mobile and armed with powerful mandibles adaptations that they use to assassinate host larvae before consuming the host's provision masses. Larvae of nearly all solitary species and most eusocial species receive an individual cache, or mass provision of pollen moistened with nectar or occasionally floral oils. Provision shape and consistency varies from firm spherical pellets to a soupy gruel on

which the larva actually floats. The larvae pass through four molts (so five instars) to accommodate their rapid growth, consuming their provision mass in few weeks. Larvae do not defecate until they mature. Once the provision mass is consumed, larvae of many (but not all) species then spin a cocoon. The final larval stage is the prepupa, which is more robust and resistant to desiccation than the earlier instance, but still grub-like. This is the typical resting, or a diapause stage of those temperate-zone species whose single adult generation flies later in spring or summer. Unlike most other insects, bees do not weather inhospitable seasons as pupae. Rather bee pupae are quite delicate resembling waxen versions of the adult. If a bee species is one that flies in the early spring (allowing little warmth for further development), then the pupal stage lasts only a few weeks, yielding an adult that will remain in the cocoon (or nest cell) to overwinter. Some halictids (sweat bees) as well as bumble bees emerge as adults, mate, and then disperse before overwintering.

4. OBJECTIVES OF RESEARCH

Due to the lack of taxonomic studies of this superfamily in Painganga Wild life Sanctuary, so the aims of present works are:

- A comprehensive survey of some localities of Painganga Wild life Sanctuary to collect the samples of the bees.
- A detailed description of the type of the superfamily and the available species.
- To Formulate of taxonomic keys to isolate the species, genera and families.
- Identification of species according to the diagnostic characters.
- Drawing of the important parts of each species.
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- Thus, this study aims to document the bee fauna of Painganga Wild life Sanctuary that may provide baseline data for future research on bee biodiversity, ecology, and conservation.

5. MATERIALS AND METHODS

5.1 Study Area

The Painganga Wildlife Sanctuary fascinating geographic features, luscious landscapes and a vast range of activities, which is much more than a refuge for the animals. In this 325 square kilometers land of a wildlife sanctuary, one can expect such rich, diverse flora and

fauna that it would be hard to ignore revisiting here again and again. The wildlife sanctuary got its name from the facts that it is flanked by river Painganga or Penganaga River on the three sides. The Central region of the sanctuary is dominated by a wide valley, which forms the border of Nanded and Yavatmal districts. Not only the landscapes but the vivacious variety of flora and fauna too also makes the tourists trip to Painganga Wildlife Sanctuary a little more interesting. An exquisite mixture of southern mixed deciduous forests and dry teak forests shelters a good number of undomesticated animal species like Chinkara, the Black Buck, the Nilgai Sambar, the Four Horned Antelope, Hare, Jackal, Leopard, Fox and much more. Also, a pleasing number of birds can be heard chattering in the sanctuary like Vulture, Bulbul, Dove, Kingfisher, Cuckoo, and much more.

Sampling Site:

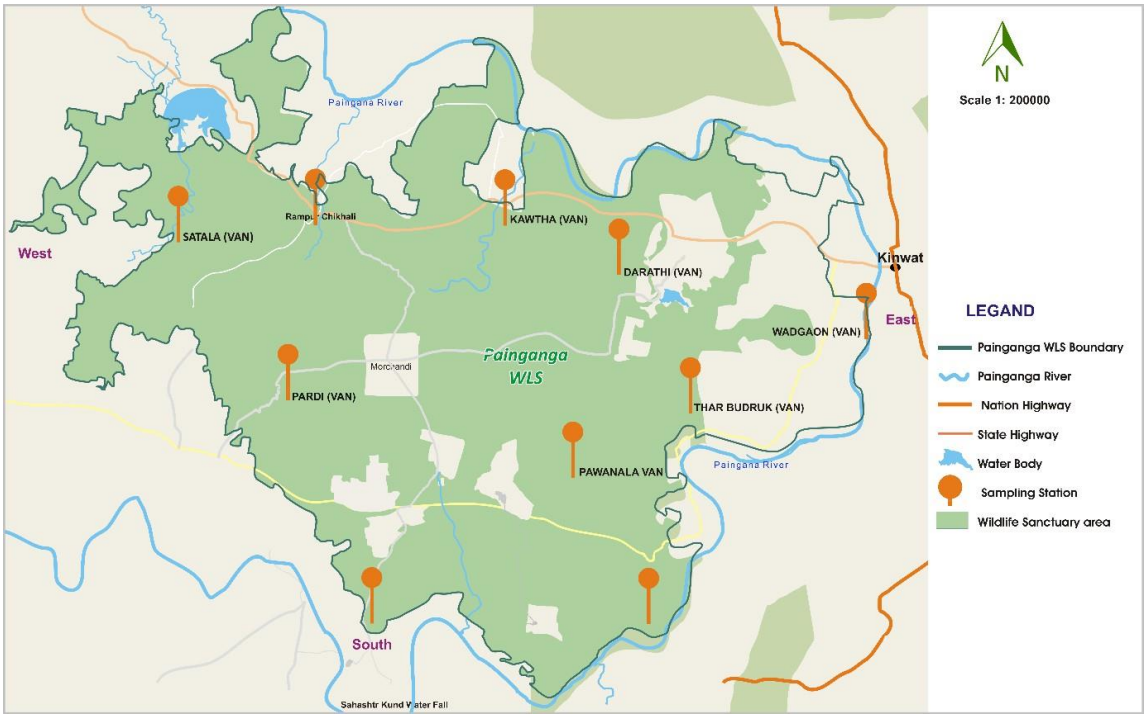

Figure 1 : Showing Purpose study site within Painganga wild life sanctuary in Yavatmal and Nanded forest Circle Maharashtra India

5.2 Samples collection

For the proposed research work the adult stage species belonged to the Superfamily Apoidea, especially members of family Apidae will be collected by sweep nets from different localities in Painganga Wildlife Sanctuary by following method of Kumar and Saksena, (2021).

5.2.1 Pinning and preserving of specimens

The Collected specimens will kill by freezing them for 48hr and after that the specimen will be pinned by using suitable volumes of pins. All information's about the specimens will be recorded (the name of the collector, location, host plant and the date of collection), and will be preserved in the insect collecting box, which will treated with (Sevin 85%) and Naphthalene balls in order to keep them from stuff insect pest (Coleoptera: Dermistidae). (Kumar and Saksena, 2021)

5.2.2 Specimen determination

The specimens will examine by using SteroZoom Microscope and dissecting binocular microscope as per need, for studying the minute parts of the body, after that these parts were drawn by using the ocular micrometer and the length of the parts were measured also by using the camera after calibrating by a linear micrometer.

5.2.3 Morphometric Analysis

The morphological characters included length of following parts: head (HD), antenna (AT), proboscis (PB), thorax (TO), abdomen (AB), fore-wing (FW), hind-wing (FL), midleg (ML), and hind-leg (HL) using a calliper will be observed and analysis as per the key and protocol (Al-Sarhan, 2019).

5.2.4 Taxon selection and Identification

The identification was accomplished by observing diagnostic characters in a series of alternate choices with the help of published keys (Al-Sarhan, 2019, Dorey and EFagan-Jeffries, 2019, Atwal and Dahiwal,2010, Bingham, 1975a 7& 1975b, 1903, Gupta and Johnathan, 2003, Hook, 2008, Shrivastava, 2004, ZSI) and available online sources such as India Biodiversity portal, Hymenoptera forum etc. Further identification of collected specimen was confirmed by comparing the specimens available in collection department of 'Bombay Natural History Society' (BNHS), Mumbai and will be confirmed from zoological Survey of India (ZSI), Pune.

5.3 Statistical analyses

We will take two multivariate approaches for analyzing the morphological data separately for males and females.

1. Principal components analysis (PCA) using SPSS version 25 for Windows (IBM Corp. 2017).
2. ANOVA to analyzed subspecies differences in morphometric parameters at $P = 0.01$. using one-way analysis of variance.

6. IMPORTANCE OF STUDY/ SOCIETY APPLICATION

6.1 International Status:

There are about 20507 species of bees worldwide. Some species may not yet have been discovered, and many are either not named or have not been well studied. Bees are found throughout the world except at the highest altitudes, in polar regions, and on some small oceanic islands. The greatest diversity of bee species is found in warm, arid or semiarid areas. Bees are highly valuable to both science and society because of their unique biology, products and services, including pollination. A trustworthy information source and efficient methods of knowledge transfer should be top priority in light of the recent global species and population losses that could endanger our ability to produce food.

6.2 National Status

There are 1699 species from 60 genera and six families are reported from India. Some species may not yet have been discovered, and many are either not named or have not been well studied. Bees have diverse nesting and social habits from alpine region to the dessert and from the deep Forest are to the Agricultural filed and are the Bees are considered to be the most effective insect in pollination service. Approximately, 75% of world's cultivated crops are pollinated by wild bees, and mutualism between plants and bees as evolved over centuries and has been helping both natural and man-made agro-ecosystems. Bee population and diversity are also vital bio-indicators of health of an environment. Therefore, the source of Information about the Bees taxonomic and diversity generated thought the proposed research will help in the increasing in the agriculture field yield of the farmers which ultimately contribution in the increasing the economy of the nation.

6.3 Regional status

Due to the lack of the taxonomic research in the proposed research area, said research will be pioneer for the region as well as for the researcher and it will contribute in the documentation Bee species-level research that is extremely dynamic, urgently needed, and in line with

contemporary social values. The taxonomic barrier that currently prevents pollinator status and pollination services from being evaluated will be directly addressed by efforts centred on proposed research work.

6.4. Scope of the study

Due to the lack of taxonomic studies of this superfamily in Painganga Wild life Sanctuary, the proposed research will be pioneer for the region as well as for the researcher and it will contribute in the documentation Bee species-level research. It will also Formulate of taxonomic keys to isolate the species, genera and families. Documentation of some ecological information such as localities, date of collection and the plant hosts for each species. Thus, this study aims to document the bee fauna of Painganga Wild life Sanctuary that may provide baseline data for future research on bee biodiversity, ecology, and conservation.

6.5. Economic importance of the bees Superfamily Apoidea Latreille,1802

Pollination :

Pollination plays an important role in flowering plant reproduction and fruit set for wildplant communities (Corbet et al., 1991; Buchmman and Nabhan, 1996). Estimates showedthat upto 90% of all flowering plant species rely on pollination by insects such as bees (Richards, 1986; Buchmman and Nabhan, 1996).

Bee venom :

Bee venom therapy is the use of live bee stings (or injectable venom) to treat various diseases such as arthritis, rheumatoid arthritis, multiple sclerosis (MS), lupus, sciatica, low back pain, and tennis elbow to name a few. It refers to any use of venom to assist the body in healing itself. Bee venom contains at least 18 pharmacologically active components includingvarious enzymes, peptides and amines. Sulfur is believed to be the main element in inducing the release of cortisol from the adrenal glands and in protecting the body from infections (Mohamed, 2012).

The Royal jelly

The royal jelly is a concentrated source of many nutrients, including all the B vitamins, as well as vitamins A, C, D and E and essential fatty acids (Bradbear, 2009).

Propolis

Propolis has anti-fungal, anti-inflammation and anti-bacterial properties. Propolis is particularly valued as a remedy for toothache, and is sold in toothpastes and chewing gums.

Bee-wax

Beeswax is used extensively in the pharmaceutical and cosmetics industries in ointments, skin creams and pills and has antibiotic properties, and can be used in the treatment of arthritis and nasal inflammations (Bradbear, 2009).

7 PROPOSED WORK PLAN

Year-wise Plan of work and targets to be achieved

7.1 First Year:

7.1.1. Reference/Literature Collection:

7.1.2. Identification of Site for Sampling

7.1.3. Collection of Specimens/Species & sorting

7.1.4. Identification of Species up to genus level based upon morphology

7.1.5 Authentication of Species (Taxon Selection and Identification)

7.1.6 Submission of Progress Report

7.1.7 Preparation of Research Paper

7.2. Second Year:

7.2.1. Collection of Specimens/Species & sorting

7.2.2. Identification of Species up to genus level based upon morphology

7.2.3 Authentication of Species (Taxon Selection and Identification)

7.2.4 Submission of Progress Report

7.2.5 Preparation & Submission Research Paper to the research Journal

7.3 Third Year

7.3.1 Results analysis

7.3.2 Data Interpretation

7.3.3 Final Compilation of Data

7.3.4 Preparation of Research Paper & Communicating it for Publication

7.3.5. Report Writing

7.3.6. Submission of Final Report to University with all details.

8 EXPECTED OUTCOMES

In real terms expected outcome often does not go beyond the description of effects on species composition of higher animal species. Keystone species are of particular relevance; changes in populations of these species have greater impacts on ecosystems than would be expected from its relative abundance or total biomass; a limited change in the number of individuals has disproportional effects on the entire system.

So, source of information generates though proposed Bee taxonomic research work would play important role in managing ecosystem, its conservation and will also help in the biodiversity management.

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